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ABSTRACT

This document outlines measures to enhance the safe transportation of children to and from school. It reports that the National Highway Traffic Safety Administration (NHTSA) is dedicated to the highest standards of safety in school buses, and it outlines some of the NHTSA guidelines, such as rollover protection, body-joint strength, seat belts, emergency exits, fuel-system integrity, handrails, nonconforming vans, and passenger seating. The report provides a brief history of NHTSA's activities related to school-bus safety, including behavioral program and vehicle regulations. It discusses current projects and future agency plans, including recent research that aims to make the next generation of school buses safer. Because children are at much greater risk of being killed as a pedestrian in a school-bus loading zone rather than as a passenger on a school bus, educating children on how to be safe pedestrians is fundamental to safety. The booklet describes various education programs for children, and it discusses the training and licensing of school-bus drivers. It analyzes motorist behavior, especially stop-arm violators and illegal passing, and the various safety enhancements that have been made to buses over the years. Two appendices provide federal motor-vehicle safety standards and other information. (RJM)

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# SCHOOL BUS Safety:

## Safe Passage for America's Children

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NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

# School Bus Safety: Safe Passage for America's Children

# School Bus Safety: Safe Passage for America's Children

## Executive Summary

School bus transportation is one of the safest forms of transportation in the United States. Every year, approximately 440,000 public school buses travel approximately 4.3 billion miles to transport 23.5 million children to and from school and school related activities. Each year on average 11 passengers, under the age of 19, die in school bus related crashes. While each of these fatalities is tragic, it should be noted that the number of fatalities among school bus occupants are small when compared to those in other types of motor vehicles. For example in 1996, 5,495 children under the age of 19 died as passengers or drivers in all other types of motor vehicles.

This excellent safety record not withstanding, NHTSA believes that school transportation should be held to the highest levels of safety, since such transportation involves the Nation's most precious cargo--children who represent our future. NHTSA has developed a comprehensive school bus safety program which is based on lessons learned from school bus crashes and related injuries and fatalities. This comprehensive program follows the principles embodied in the Haddon Matrix and addresses safety from all aspects, placing priority on the human, vehicle and environmental factors that pose the greatest risk of injury to children. Countermeasures for crash prevention, means to mitigate injury during the crash and ensuring maximum potential for survivability post crash have all been explored.

School bus pedestrian fatalities account for the highest number of school bus related fatalities each year. There are about 26 such fatalities per year, about two thirds of which involve the school bus itself and about one-third of which involve motorists illegally passing a stopped school bus. In its 1989 report National Academy of Sciences (NAS) stated that since children are at "greater risk of being killed in school bus loading zones (i.e., boarding and leaving the bus) than in the bus, a larger share of the school bus safety effort should be directed to improving the safety of school bus loading zones." NHTSA agrees with the recommendations of the NAS study and has worked to educate school bus operators, students and other motorists about safe behaviors that reduce their risks of being involved in a school bus related pedestrian crash. School bus driver training for both new and experienced drivers has been developed by NHTSA. Funding was provided to the states for

driver training. Several educational pedestrian safety programs have been developed, which teach children how to safely walk to and from the bus stop and how to safely enter and exit the bus. Informational materials for motorists on safe driving practices in and around school bus zones have been developed and distributed. The agency encourages police enforcement of safe driving practices. NHTSA has established Federal Motor Vehicle Safety Standards (FMVSS) requiring all school buses to have red and amber signal lamps and stop arms which indicate the bus is loading\unloading passengers and rear and side view mirrors that allow the driver to see areas in front of and along both sides of the school bus. Together these devices provide ways to make the vehicle more noticeable resulting in avoidance of potential crashes.

To address the safety of passengers inside the school bus in the event of a crash NHTSA has established many FMVSS's to make the school bus stronger and enable it to better protect occupants. Three standards, which address rollover protection, body joint strength, and passenger seating, are unique to school buses. Another six standards have additional requirements that provide for the protection of school bus passengers. Still other standards, which address the brakes, tires, fuel system integrity and other safety related systems, ensure that school buses have the highest level of safety when it comes to avoiding a crash in the first place or enhancing survivability after a crash. Compliance tests are conducted to assure that all these standards are met by vehicle manufacturers. Reported safety defects are investigated and, when warranted, recalls are conducted.

The primary means of occupant protection for large school buses is a concept known as compartmentalization -- strong, well padded , well anchored, high backed, evenly spaced seats. Even though compartmentalization has proven to be an excellent concept for injury mitigation, the agency has initiated a research program to develop the next generation of occupant protection for school bus passengers. This comprehensive program will evaluate alternative occupant crash protection systems in controlled laboratory tests that represent the types of real world school bus crashes that produce injuries to passengers. A key component of this program will necessarily be a thorough search for better crash data. Existing state and school systems records will be searched for documentation on school bus crashes involving fatalities/injuries and specific crashes in which seat belts were used. Those crash data will be vital to defining the test conditions that best simulate the most injurious school bus crashes. Alternative systems will be tested

and evaluated for their ability to protect the full range of bus occupants without unduly reducing occupant capacity of the bus or restricting emergency egress. If it is determined that all these criteria can be met, the agency will consider upgrading its occupant protection standards.

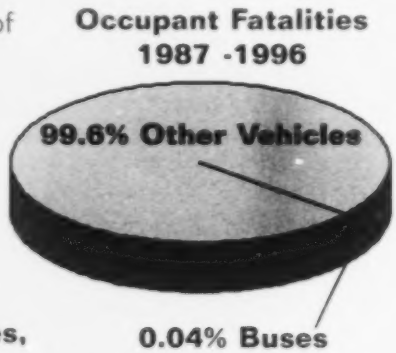
NHTSA is committed to working with our partners -- states, communities, pupil transportation associations, and manufacturers to assure that school transportation continues to be the safest form of transportation in the country.

## I. Introduction to School Bus Safety

The National Highway Traffic Safety Administration (NHTSA) is dedicated to saving lives, preventing injuries, and reducing economic costs from traffic crashes. The past several decades have witnessed dramatic reductions in the number of people killed and injured on the nation's highways. Part of this success can be attributed to NHTSA's expanded safety partnerships, increased focus on crash injury, and the provision of educational tools for safety advocates.

Every year, approximately 440,000 public school buses travel about 4.3 billion miles to transport 23.5 million children to and from school and school-related activities. The school bus occupant fatality rate of 0.2 fatalities per 100 million vehicle miles traveled (VMT) is much lower than the rates for passenger cars (1.5 per 100 million VMT) or light trucks and vans (1.3 per 100 million VMT).

In the 10 year period, 1977 to 1986, an average of 12 school bus occupants and 47 pedestrians, under the age of 19, were killed annually in school bus related crashes. The number decreased in the last 10 year period, 1987 to 1996, to an average of 10 school bus occupants and 25 pedestrians. **Pedestrian fatalities (while loading and unloading school buses) account for approximately three times as many school bus-related fatalities, when compared to school bus occupant fatalities.** While each of these fatalities is tragic, the numbers are small when compared to the average number of occupants under the age of 19 killed in other motor vehicle crashes (6,118) over the past 20 years. **School buses have been and remain the safest form of highway transportation.**

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NHTSA's General Estimates System (GES) provides insight into the number of passenger injuries in school bus crashes. GES estimates from 1988 to 1996 indicate that there are approximately 8,500 injuries in school buses each year. The overwhelming majority of these injuries, approximately 7,285 would be considered minor, 885 would be considered moderate, and the remaining 350 would be considered serious to critical.

These numbers do not fluctuate widely from year to year, as some suggest. This data system provides reliable crash information based on proven statistical methods that provide analysis of injuries to occupants in school buses.

NHTSA has developed a comprehensive school bus safety program based on school bus crashes and related injuries and fatalities. This comprehensive program follows the principles embodied in the Haddon Matrix and addresses school bus safety from the human, vehicle, and environmental aspects looking at countermeasures for crash prevention, means to mitigate injury during the crash and ensuring maximum potential for survivability post crash. While the agency's program addresses all aspects of school bus safety, it has focused on the greatest threat to school age passengers, pedestrian safety in the school bus loading zone. This focus on loading zone safety has been on both the vehicle side and the human side. NHTSA has established Federal Motor Vehicle Safety Standards (FMVSS) requiring all school buses to have red and amber signal lamps and stop arms which indicate the bus is loading/unloading passengers and rearview mirrors that allow the driver to see areas (and thus, small children) in front of and along both sides of the school bus. Together, these devices provide ways to make the vehicle more noticeable, thereby helping avoid potential crashes. The agency also recommends all school buses be painted school bus yellow. The use of a uniform color makes school buses easily recognizable.

On the human side, NHTSA has worked to educate school bus operators, students, and othermotorists about safe behavior that reduces the risk of being involved in a school bus-related pedestrian crash. School bus driver training for both new and experienced drivers has been developed by NHTSA. Funding was provided to states for driver training. Several educational pedestrian safety programs have been developed by the agency. The programs teach children how to safely walk to and from the bus stop and how to safely enter and exit the school bus. Informational materials informing motorists of safe driving practices in and around school bus zones have been distributed.

To address the safety of passengers inside the school bus in the event of a crash, NHTSA has established many FMVSS's that make the school bus stronger and enable it to better protect occupants. Four safety standards are unique to school buses and another six safety standards have special requirements that provide for the protection of school bus passengers. Together, all FMVSS's regulating school buses enable the school bus to provide each passenger a very high level of safety.

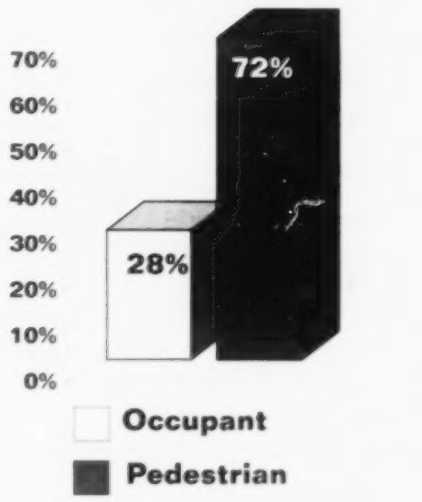
NHTSA is committed to providing the nation's school children the safest school transportation possible. Therefore, NHTSA is initiating further research to evaluate new and current school bus occupant protection systems. In addition, the agency plans to expand its current behavioral and vehicular initiatives to continue improving school bus safety.

This report provides a brief history of NHTSA's activities related to school bus safety including behavioral programs and vehicle regulations. It discusses current projects and future agency plans including the research just under way to make recommendations for the next generation occupant protection in school buses.

## II. Behavioral Programs

Data and experience show that children are at much greater risk of being killed as a pedestrian in a school bus loading zone than as a passenger on a school bus. The area surrounding the school bus is commonly referred to as the "Danger Zone" because it is the area where children entering and exiting the school bus are at greatest risk of being hit by a motor vehicle. Over the past 10 years, on average, about three- fourths of school-age children who die in school bus-related crashes each year are pedestrians.

**School Bus-Related Fatalities 1987 -1996**




Educating children on how to be safe pedestrians is fundamental to school bus safety. Beginning with their first step onto a school bus, children must learn how to safely arrive at the school bus stop, board the bus, behave during the bus ride, and exit the bus.

School bus drivers also play a critical role in the safety of school bus passengers. School bus driver training is central to the development of the skills and knowledge needed to safely

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transport students. Strong licensing requirements (administered by Federal Highway Administration and the states) ensure drivers possess the skills they need to safely perform their jobs.

In addition, motorists sharing the road with school buses are often unaware of the effect they have on the safety of school bus passengers. Communities are encouraged to implement educational programs to increase motorists' awareness of their pivotal role in keeping school bus passengers safe.

### A. Pedestrian/Occupant Safety

**Pupil Education:** For more than two decades, NHTSA has been developing and implementing effective programs for addressing pedestrian safety involving pupils in school bus loading zones on the way to and from school. In the mid 1970's, the agency produced and distributed the *Willie Whistle* educational program. This program, which was updated in the late 1980's, teaches young children (K-3) how to become safer pedestrians. It focuses on the most frequent type of pedestrian crash young children are involved in: darting into the street without stopping or looking. NHTSA also produced *Walking With Your Eyes,* a pedestrian safety video for older children (grades 4-7). Both of these programs teach safety behavior that directly relates to the children's ability to safely enter or exit a school bus.

In 1995, NHTSA, in partnership with the National Safety Council, developed *Walk, Ride, Walk - Getting To School Safely,* a comprehensive education program for elementary school children (K-6). The educational package includes teacher lesson plans, educational videos, and support materials for parents and school bus drivers. The program teaches children how to safely walk to and from the school bus stop, board and exit the bus, and safely ride on the bus.

On September 23, 1998, The Partnership for a Walkable America, a coalition of public and private safety organizations, will sponsor the second annual National Walk Our Children to School Day. This program sets aside a day for community leaders, parents and children to walk students to school or their school bus stops and along the way teach pedestrian safety and identify safe travel routes.

Around the same time, NHTSA will release a kid's activity book, *Back to School Safely.* The book contains a board game, crossword puzzle, songs, and rhymes that teach children how to travel to and from school safely. The booklet addresses the many forms of transportation children use to get to school:

school bus, bicycle, pedestrian, and family cars. In addition to these publications, NHTSA has an interactive Web Site that includes the *"School Bus Safety Page"* which teaches children the essentials of school bus and traffic safety. [http://www.nhtsa.dot.gov/kids/bussafety]

**B. Driver/Operator Issues**

**Training:** In 1974, NHTSA published the School Bus Driver Instructional Program. This standardized comprehensive school bus driver training program provided states and local pupil transportation managers with educational materials to teach core skills and knowledge needed by a school bus driver. In 1976, funds under 23 U.S.C. section 406 were made available to all states to conduct school bus driver training, and by 1983, states had expended $33 million.

In fiscal years 1990 and 1991, the Department of Transportation made a total of $4.5 million available to states to implement school bus safety countermeasures. In both years, most states used the funds to support school bus driver training. Other areas supported through this funding included pedestrian and bicycle safety activities related to school transportation, and public information and education measures aimed at urging motorists to observe school-bus-related traffic laws and use caution when in school bus loading zones.

In September 1998, NHTSA will release the newly developed *School Bus Driver In-Service Safety Series*. This training program will provide pupil transportation managers across the country the lesson plans and materials they need to conduct in-service training for their school bus drivers. The series contains seven modules that can be taught individually or in combination. The topics include driver attitude, student management, highway-rail grade crossing safety, vehicle training, knowing your route, loading and unloading, and transporting infants and toddlers. Additional modules will be developed in association with the pupil transportation community.

In 1996, Operation Lifesaver, Inc., an organization dedicated to reducing collisions, injuries and fatalities at highway-rail grade crossings, produced a training program, *The Responsibility Is Ours*, for school bus drivers that addresses highway-rail grade crossing safety. The program was created in partnership with NHTSA, Federal Highway Administration, Federal Railroad Administration, Federal Transit Administration, and the pupil transportation industry. The program illustrates the potential dangers school bus drivers face when crossing highway-rail grade crossings and reviews the rules drivers must follow to cross safely.

**Licensing:** The Federal Highway Administration administers the Commercial Driver's Licensing (CDL) program, which helps to maintain and improve school bus safety by ensuring that drivers of school buses are qualified to operate those vehicles. The program became effective on April 2, 1992. To obtain a CDL, school bus drivers must pass tests to prove they possess the skill and knowledge needed to safely operate vehicles used to transport children to and from school and school-related activities. Each state requires additional school bus specific training for all school bus operators.

**Routing:** The routing of school bus travel and stops is an important element in keeping passengers safe. When establishing school bus routes, transportation managers must determine the safest routes to use and the safest locations for students to meet the bus. Once routes are established, it is vital for school bus drivers to report any hazards not identified by the route manager or new hazards that develop on the route (i.e. road construction, flood area, etc.). To help pupil transportation managers establish safe school bus routes, the National Association of State Directors of Pupil Transportation Services, supported by a grant from NHTSA, released a report that school transportation officials can use in developing a system for identifying school bus route hazards. The report provides guidelines on how to develop a localized system for identification of route hazards and notification to regular and substitute drivers of hazards on the routes they drive. The document also reports methods drivers can use to notify officials of new or changing hazards on their bus routes.

### C. Motorists Behavior

**Stop arm violators/illegal passing:** In 1996, NHTSA published the widely distributed brochure entitled *Kids, the School Bus and You,* which contains a section for motorists explaining the extra precautions they need to take when driving near a school bus stop. It explains when and why a school bus engages its yellow flashing lights, red flashing lights, and stop arm, and what actions a motorist should take when the devices are engaged.

In September 1997, NHTSA provided the Florida Department of Education a grant to support a statewide program to reduce the incidence of motorists illegally passing school buses stopped to load or unload children. This program centers on increasing public awareness and knowledge of the state law requiring motorists to stop before reaching a school bus with its red lights flashing and stop arm deployed. Florida's program contains a law enforcement component that provides for

increased enforcement of the law and an easy way for the public to report stop arm violators.

By September 1998, the agency will award four additional grants to support community programs designed to decrease the number of motorists illegally passing school buses. These grants will support one year programs focusing on increasing public awareness of state laws requiring motorists to stop for school buses during loading/unloading, and of the danger children face when motorists do not obey the laws. Each grant program will also support increased law enforcement of state school bus traffic laws.

In 2000, NHTSA will publish the results of the five grant programs together with results other communities have obtained through similar programs. The publication will highlight the techniques each program used and the success they experienced. This publication will be widely distributed to assist other communities in their efforts to address the illegal passing problem.

### III. Vehicle Programs

In the legislative history of the School Bus Safety Amendments of 1974, Congress indicated that school transportation should be held to the highest level of safety, since such transportation involves the Nation's most precious cargo -- children who represent our future. Consistent with the 1974 Congressional mandate for school bus safety, NHTSA has established school bus safety standards requiring higher levels of safety performance for school buses than other passenger vehicles.

As a result of the passage of the National Traffic and Motor Vehicle Safety Act of 1966 and the School Bus Safety Amendments of 1974, NHTSA currently has 35 Federal Motor Vehicle Safety Standards (FMVSS) that apply to school buses. (Appendix A) The 1974 amendments directed NHTSA to establish or upgrade school bus safety standards in eight areas: emergency exits, interior occupant protection, floor strength, seating systems, crashworthiness of the body and frame, vehicle operating systems, windshields and windows, and fuel systems. As a result of the 1974 amendments, three new motor vehicle safety standards were established and four existing standards were amended.

Today, there are four standards unique to school buses and six standards that have unique requirements specific to school buses. Table 1 below presents a summary of these safety standards and a brief description of those requirements.

# TABLE No 1: SAFETY ENHANCEMENTS OF SCHOOL BUSES

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| Standard No. 105: | Hydraulic Brake System—Requires school buses utilizing hydraulic brakes to stop in shorter distances. |
| Standard 108: | Lamps, Reflective Devices and Associated Equipment—Requires red and amber signal lamps, which indicate the bus is loading/unloading passengers. |
| Standard No. 111: | Rearview Mirrors—Requires the driver be able to see either directly or through a system of mirrors certain areas in front of and along both sides of the school bus. |
| Standard No. 131: | School Bus Pedestrian Safety Devices—Requires a stop arm that extends on the left side of the bus to warn motorist when it is loading/unloading passengers. |
| Standard No. 217: | Bus Emergency Exits and Window Retention and Release — Requirements that specify means of readily accessible emergency egress, make the emergency exits easier for children to use and increased conspicuity, to aid nighttime evacuation. |
| Standard No. 220: | School Bus Rollover Protection–Specifies minimum strength requirements for school bus roofs to reduce the likelihood of roof collapse in a rollover, and requires that emergency exits (except roof exits) be operable after the roof is subjected to forces that can be encountered in rollovers. |
| Standard No. 221 | School Bus Body Joint Strength—Specifies minimum strength requirements for body panel joints to improve the structural integrity of the passenger compartment and to reduce the likelihood of lacerative injuries to occupants caused by the sharp edges of body panels that tear loose in crashes. |
| Standard No. 222: | School Bus Passenger Seating and Crash Protection—Specifies seating, restraining barrier, and impact zone requirements for school buses. The standard relies on compartmentalization between well-padded and well-constructed energy absorbing seats to provide occupant protection. Specifies requirements for wheelchair restraint systems. |
| Standard No. 301: | Fuel System Integrity—Specifies requirements for the integrity and security of the entire fuel system, including the fuel tanks, fuel pump, fuel delivery system, emission controls, lines, and connections in severe barrier impact crash tests. |
| Standard No. 303: | Fuel System Integrity of Compressed Natural Gas Vehicles—Specifies requirements for the integrity and security of the entire fuel system and connections in severe barrier impact crash tests. |

NHTSA enforces these standards through its Compliance Test Program. The Office of Vehicle Safety Compliance conducts yearly compliance test programs to assure that school buses meet FMVSS's. There have been numerous recalls to address noncompliances with FMVSS.

### A. Pre-Crash Safety

**Conspicuity:** Highway Safety Program Guideline #17, Pupil Transportation Safety recommends that all school buses be painted "school bus yellow". NHTSA believes that there is a safety advantage to the uniformity of color that makes school buses easily recognizable. A recent rulemaking also requires that all emergency exits have retroreflective tape around the outside perimeter to aid in nighttime rescues.

**Stop arms:** Standard No. 131, "School Bus Pedestrian Devices" requires stop arms on all school buses and became effective for all new school buses manufactured after September 1992. The standard was modified in May 1994 to allow the use of strobe lights on the stop arms and again modified in May 1998 to allow additional light sources in the legend that flash the word "STOP." This safety standard was implemented to inform motorists to stop for a school bus while loading or unloading school children. This should help reduce the number of children killed by illegally passing motorists.

**Mirrors:** Effective December 1993, Standard No. 111, "Rearview Mirrors" was amended to require that the driver be able to see either directly, or through a system of mirrors, certain areas in front of and along both sides of the school bus. This gives the driver a better view of those areas and helps reduce the number of children killed by the school bus during loading or unloading. In addition to Standard No. 111, NHTSA has also recently evaluated two Doppler microwave radar-based pedestrian detection systems that are commercially available. It was found to be a promising technology for preventing school bus pedestrian incidents.

**School Bus Passenger Seating and Crash Protection:** Effective January 1994, FMVSS No. 222, "School Bus Passenger Seating and Crash Protection" was amended to require performance standards for wheelchair tiedowns and occupant restraint systems.

### B. Crash

**Occupant Protection:** During the rulemaking process in the early 1970's, when the school bus safety standards were being established, NHTSA looked carefully at available injury and

fatality data, existing research, and public comments submitted to the agency to determine what system of occupant protection should be required in school buses. Research conducted at UCLA in 1967 and 1972 evaluated existing seats used on school buses. That research showed great weaknesses in existing seating systems. Those findings led NHTSA to issue a contract to AMF Corporation to design new, protective school bus seating systems that provided uniform levels of protection to seated occupants ranging in size from a six-year old (46 lbs., 48" in height) to a 50th Percentile male (165 lbs., 5'10" in height).

Recognizing that school bus vehicles are heavier, experience lesser crash forces, and distribute crash forces differently than do passenger cars and light trucks, it was determined that the best way to provide crash protection to children on large school buses was to use a concept called "compartmentalization." This method provides a protective envelope consisting of strong, closely-spaced seats that have energy-absorbing seat backs. Compartmentalization along with the enhanced safety standards such as joint integrity of the bus body panels and the stringent fuel system integrity requirements make school buses the safest vehicles on the road.

**Pre-School Age:** With the increasing number of pre-school children being transported by school buses, the pupil transportation community asked for guidance on how to safely transport them. Most large school buses do not have seat belts or anchorages for child restraints. NHTSA recently conducted dynamic tests to evaluate the most beneficial method(s) to transport pre-school aged children, taking into consideration the use of seat belts, child safety seats and available spacing between bus seats. Based on these crash test results, the agency determined, just like in the family car, pre-school age children should be in a child restraint system when they are transported in a school bus. In conjunction with many organizations and groups involved in transporting pre-school age children, NHTSA developed a draft set of guidelines, with the final guidelines scheduled to be released in October 1998. NHTSA's draft guidelines recommend the installation of lap belts or anchorages designed for securing child restraint systems on large school buses. Just as in automobiles, the agency does not recommend pre-school age school bus passengers wear lap belts as an occupant protection device.

**Seat Belt Issue:** NHTSA has continuously monitored and evaluated school bus crash data and research conducted on school bus occupant protection. The existing data and research have continued to validate the effectiveness of the existing

passive occupant protection system on school buses carrying elementary through high school age children. However, the agency will endeavor to substantially upgrade existing data as an integral component of its research program to develop the next generation of occupant protection for school bus occupants. Existing state and school system records will be searched for documentation on school bus crashes involving fatalities/injuries and specific crashes in which seat belts were used. These crash data will be vital to defining the test conditions that best simulate the types of school bus crashes that produce injury to bus occupants.

Studies that have supported the use of compartmentalization for school bus occupant protection include the National Transportation Safety Board's *Crashworthiness of Large Poststandard School Buses* and the National Transportation Research Board's *Special Report 222: Improving School Bus Safety*. In a 1987 study of large school bus crashes, the National Transportation Safety Board (NTSB) concluded that most fatalities and injuries to children riding in school buses occurred because those children were in the seats that happened to be directly in line with the crash forces in that particular crash (i.e. a train colliding with a school bus). NTSB stated that seat belts would not have prevented most of the serious injuries and fatalities occurring in school bus crashes.

This work was followed up by the National Academy of Sciences (NAS), which assembled an independent panel of safety experts to study ways of improving school bus safety. In 1989, NAS concluded that the overall potential benefits of requiring seat belts on large school buses were too small to justify a Federal requirement for mandatory installation. NAS also stated that the funds used to purchase and maintain seat belts might be better spent on other school bus safety programs and devices that could save more lives and reduce more injuries. States are free to require the installation of lap belts on their large school buses and currently there are two states that have done so, New York and New Jersey. New York required the installation on all new school buses beginning June 30, 1987, New Jersey passed a law in 1992 requiring installation and use of lap belts on all new large school buses. The agency will be working with these two states in an effort to secure whatever crash data is available to assess the injury reducing potential of lap belts.

**Next Generation Safety Systems Research Plan:** Even though compartmentalization has proven to be an excellent form of occupant protection, the agency has initiated an extensive research program to develop the next generation occupant protection system. The objective of NHTSA's Research Plan

(Appendix B) is to (1) Enhance the current crash data for school buses to better define the types of crashes that produce injury to school bus occupants and to scientifically determine the real-world effectiveness of current Federal requirements for school bus occupant crash protection, (2) evaluate alternative occupant crash protection systems in controlled laboratory tests that represent the types of real-world school bus crashes, and (3) based on the findings, propose the next generation of occupant protection requirements for school buses. Each system studied must meet all of the following criteria: (1) is likely to reduce the total number of injuries or fatalities associated with school bus crashes, (2) provides protection to the whole range of occupants who are transported in school buses, (3) is technologically feasible (4) reasonable in cost and (5) does not substantially reduce the occupant capacity of school buses or substantially inhibit emergency evacuation.

**Planned Research:** Research will be conducted in three (3) phases: Phase I - Problem Definition, Phase II - Test Procedure Development, and Phase III - Testing and Validation.

**Phase I: Problem Definition** will consist of analyzing Fatal Analysis Reporting System, General Estimates System and National Automotive Sampling System databases for school bus crashes and corresponding injuries, a literature search for existing school bus related research, identification of safety systems that are currently available or will be in near term, and in-depth special investigations of existing state and school system records on bus crashes involving fatalities/injuries and specific crashes in which seat belts were used. Detailed review of crash data to upgrade existing data to better define crashes that produce injury to occupants.

**Phase II: Test Procedure Development** will consist of developing test conditions that best simulate the types of crashes that lead to serious injuries, as identified through Phase I research. Crash "pulses" will be developed by conducting full scale school bus crash testing at various impact angles. Using the derived crash pulses, a sled test procedure (crash simulation) will be developed and validated. Design and, if necessary, develop new occupant protection countermeasures by modifying existing systems and components or developing new systems. Preliminary tests to verify the systems will be conducted prior to final sled testing. A sled test matrix to evaluate the new or altered occupant protection systems will be developed.

**Phase III: Testing and Validation** will consist of testing the various safety systems developed or identified. The types of

tests to be conducted will be both static (i.e., FMVSS 222) and dynamic (new sled test procedure). Test results will be analyzed and a final report published.

### C. Post Crash Safety

**Emergency Exits:** Recently, Standard No. 217, "Bus Emergency Exits and Window Release and Retention" was amended to require additional emergency exits on school buses and specify that retroreflective tape be placed around the exterior perimeter of all emergency exits. This became effective for all new school buses manufactured after September 1994. For a typical 66-passenger school bus, this requirement resulted in an additional side door, or two emergency exit windows, and a roof exit.

**Fuel System Integrity:** Standard No. 301 "Fuel System Integrity" specifies requirements for the integrity and security of the entire fuel system, including the fuel tanks, fuel delivery system, emission controls, lines, and connections in severe barrier impact crash tests. This ensures that fuel systems do not leak when impacted by a 4000 pound rigid face barrier at any point and any angle. One hundred eighty-five thousand buses were recalled in 1992 and another 30,000 buses between 1997 and 1998 for failure to meet the requirements of FMVSS 301, fuel system integrity.

**School Bus Body Joint Strength:** In March 1991, NHTSA proposed to amend FMVSS No. 221 to remove the exemption for maintenance access panels and make small school buses (GVWR$\leq$ 10,000 pounds) applicable to these requirements. Should a final rule result from this proposal, NHTSA believes that this will reduce 27 to 36 injuries annually.

### E. Other Issues

**Handrails:** In 1991, NHTSA's Office of Defects Investigation began investigating reports of incidents involving students snagging clothing, book bags, and other items on bus handrails as they exited school buses. NHTSA is aware of six fatal incidents and many more non-fatal incidents involving handrail snagging. Since 1993, when NHTSA gave its first public warning about the handrail snagging problem, there have been 35 handrail recalls involving 429,853 school buses from the 1977 through 1997 model years.

NHTSA also took action to notify the public of this potential danger. Beginning in 1993, NHTSA issued press releases alerting the public of the potential of clothing drawstrings and bookbag straps snagging in school bus handrails. Press releases

also were sent out in 1994 and 1995. In May 1995, NHTSA broadcast a Video News Release to television stations throughout the nation alerting the public to the handrail snagging problem. One page *School Bus Safety Alerts* were given to school bus drivers, parents and teachers. Letters were sent to all State school transportation officials warning of handrail snagging problems and consequent recalls in 1993, 1994, and 1995. The Secretary of Transportation wrote to each State Governor telling them of the problem and requesting they make certain each school bus in their state was inspected and if the bus was covered by a recall, fixed.

A variety of formats were used to provide information on how to inspect school buses for defective handrails and on how to get a defective handrail fixed, including the publication *This Could Save Your Child's Life, A School Bus Handrail Handbook* and an instructional video. In February 1996, the Consumer Product Safety Commission released guidelines for drawstrings on children's clothing to help prevent children from being strangled or getting entangled in a variety of potentially dangerous situations, including handrails.

**Use of Nonconforming Vans**: New vehicles that carry 11 or more persons that are sold for transporting students to or from school or school related events are required to meet all FMVSSs for school buses. A vehicle is regarded as being sold for use as a school bus if, at the time of sale, it is evident that the vehicle is likely to be significantly used to transport students to or from school or school related events. This applies to school buses sold to public as well as private schools. Thus, a dealer selling a new 12 or 15-passenger van to be used for school transportation must ensure that the van is certified as meeting all school bus FMVSSs.

In addition to investigating and imposing of civil penalties on dealerships that have illegally sold 12-15 passenger vans to schools NHTSA has taken steps to educate the public, pupil transportation industry, and automobile dealerships about the laws governing such sales to school systems. In October 1995 letters were sent to State Directors of Pupil Transportation and State Automobile Dealers Associations explaining the prohibition on selling to school systems, vehicles that seat 11 or more and do not meet school bus Federal Motor Vehicle Safety Standards. Similar letters were sent again in October 1997. At that time letters were also sent to the National PTA and PTA state offices, and the American Automobile Manufacturers Association. Agency staff have also spoken about non-conforming vehicles at many pupil transportation and highway safety conferences.

Within the past two years, NHTSA has investigated allegations that dealers have violated this requirement. In May 1998, the agency issued a press release announcing the agency had completed investigations into vehicle dealers which illegally sold or leased vans that were used as school buses and obtained civil penalties totaling $14,400 from 10 dealers. The announcement also contained information on how to report a suspected illegal sale or lease of vans that are used in pupil transportation.

NHTSA is currently conducting five additional investigations of dealerships reported to have illegally sold vans to school systems. The agency will continue to publicize the safety risks of transporting students in vehicles other than school buses and investigate all violations reported to the agency.

NHTSA strongly recommends that only vehicles meeting Federal school bus safety standards be used to transport school children. Highway Safety Program Guideline 17, Pupil Transportation Safety, specifically recommends that any vehicle designed to carry more than 10 persons and which is used as a school bus comply with all Federal safety standards applicable to school buses at the time the vehicle was manufactured.

Some states do allow the use of non-school bus vehicles to transport students. This is of great concern because students being transported in these vehicles are not receiving the level of protection they are provided in a vehicle that meets all school bus safety standards.

# Appendix A. Federal Motor Vehicle Safety Standards Applicable to School Buses

(Items In Bold Are Unique To School Buses)

FMVSS No. 101 - Controls and Displays: Specifies requirements for the location, identification, and illumination of motor vehicle controls and displays.

FMVSS No. 102 - Transmission Shift Lever Sequence, Starter Interlock, and Transmission Braking Effect: Specifies the requirements for the transmission shift lever sequence, a starter interlock, and for a braking effect of automatic transmissions.

FMVSS No. 103 - Windshield Defrosting and Defogging Systems: Specifies requirements for windshield defrosting and defogging systems.

FMVSS No. 104 - Windshield Wiping and Washing Systems: Specifies requirements for windshield wiping and washing systems.

FMVSS No. 105 - Hydraulic Brake Systems: Specifies requirements for hydraulic service brake and associated parking brake systems. Increased the requirements for hydraulic brakes.

FMVSS No. 106 - Brake Hoses: Specifies labeling and performance requirements for motor vehicle brake hose, brake hose assemblies, and brake hose end fittings.

FMVSS No. 108 - Lamps, Reflective Devices, and Associated Equipment: Specifies requirements for original and replacement lamps, reflective devices, and associated equipment.

FMVSS No. 111 - Rearview Mirrors: Specifies requirements for the performance and location of interior and exterior rearview mirrors. Establishes requirements for "crossview" mirror to see in front of and alongside the bus, and that the driver clearly see specific areas to the ground along the sides and around the front of the school bus.

FMVSS No. 113 - Hood Latch System: Specifies the requirement for providing a hood latch system or hood latch systems.

FMVSS No. 116 - Motor Vehicle Brake Fluids: Specifies requirements for fluids for use in hydraulic brake systems of motor vehicles, containers for these fluids, and labeling of the containers.

FMVSS No. 119 - New Pneumatic Tires for Vehicles Other Than Passenger Cars: Specifies performance and marking requirements for tires for use on multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles.

FMVSS No. 120 - Tire Selection and Rims for Motor Vehicles Other Than Passenger Cars: Specifies tire and rim selection requirements and rim marking requirements for use on multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles.

FMVSS No. 121 - Air Brake Systems: Specifies performance and equipment requirements for braking systems on vehicles equipped with air brake systems.

FMVSS No. 124 - Accelerator Control Systems: Specifies requirements for the return of a vehicle's throttle to the idle position when the driver removes the actuating force from the accelerator control system, or in the event of a severance or disconnection in the accelerator control system.

**FMVSS No. 131 - School Bus Pedestrian Safety Devices:** Specifies requirements for devices that can be installed on school buses to improve the safety of pedestrians in the vicinity of stopped school buses. Applicable to all school buses. Amended May 28, 1998 and now permits light emitting diodes or LED lighting on stop signal arm.

FMVSS No. 201 - Occupant Protection in Interior Impact: Specifies requirements to afford impact protection for occupants.

FMVSS No. 202 - Head Restraints: Specifies requirements for head restraints.

FMVSS No. 203 - Impact Protection for the Driver from the Steering Control System: Specifies requirements for steering control systems.

FMVSS No. 204 - Steering Control Rearward Displacement: Specifies the requirements limiting the rearward displacement of the steering control into the passenger compartment.

FMVSS No. 205 - Glazing Materials: Specifies requirements for glazing materials for use in motor vehicles and items of motor vehicle equipment.

FMVSS No. 207 - Seating Systems: Specifies requirements for seats, their attachment assemblies, and their installation.

FMVSS No. 208 - Occupant Crash Protection: Specifies performance requirements for the protection of vehicle occupants in crashes.

FMVSS No. 209 - Seat Belt Assemblies: Specifies requirements for seat belt assemblies.

FMVSS No. 210 - Seat Belt Anchorages: Specifies requirements for seat belt assembly anchorages.

FMVSS No. 212 - Windshield Mounting: Specifies windshield retention requirements for motor vehicles during crashes.

FMVSS No. 214 - Side Door Strength: Specifies performance requirements for protection of occupants in side impact crashes.

FMVSS No. 217 - Bus Emergency Exits and Window Retention and Release: Specifies requirements for the retention of windows other than windshields in buses, and establishes operating forces, opening dimensions, and markings for push-out bus windows and other emergency exits.

FMVSS No. 219 - Windshield Zone Intrusion: Specifies limits for the displacement into the windshield area of motor vehicle components during a crash.

**FMVSS No. 220 - School Bus Rollover Protection:** Specifies performance requirements for school bus rollover protection. This standard increases the structural resistance of school buses in rollover-type accidents. This standard only applies to school buses and covers all styles of school bus.

**FMVSS No. 221 - School Bus Body Joint Strength:** Specifies requirements for the strength of the body panel joints in school bus bodies. This standard improves the body strength of school buses through increased strength of the joints between panels that comprise the bus body. Applicable to all school buses with a gross vehicle weight rating (GVWR) in excess of 10,000 pounds.

**FMVSS No. 222 - School Bus Passenger Seating and Crash Protection:** Specifies occupant protection requirements for school bus passenger seating and restraining barriers. This standard provides increased protection to passengers through a series of interior changes known as "compartmentalization" — meaning high-backed, well-padded, and well-constructed seats. This standard only applies to school buses and covers all styles of school bus.

FMVSS No. 301 - Fuel System Integrity: Specifies requirements for the integrity of motor vehicle fuel systems. Establishes fuel system integrity requirements for school buses over 10,000 pounds gross vehicle weight rating (GVWR).

FMVSS No. 302 - Flammability of Interior Materials: Specifies burn resistance requirements for material used in the occupant compartments of motor vehicles.

FMVSS No. 303 - Fuel System Integrity of Compressed Natural Gas Vehicles: Specifies requirements for the integrity of motor vehicle fuel systems using compressed natural gas (CNG),including the CNG fuel systems of bi-fuel, dedicated, and dual fuel CNG vehicles.

FMVSS No. 304 - Compressed Natural Gas Fuel Container Integrity: Specifies requirements for the integrity of compressed natural gas fuel containers used in all motor vehicles.

# Appendix B. Research Plan

### Phase I: Problem Definition

Analyze existing Department of Transportation databases including the Fatal Analysis Reporting System, General Estimates System, and National Automotive Sampling System for school bus crash information and corresponding injury data.

Perform literature search for existing school bus related crash and occupant protection research.

Issue Federal Register notice asking public for input on school bus occupant protection systems that should be tested and crash pulses that should be used.

Perform in-depth special investigations of existing state and school system records on bus crashes involving fatalities/ injuries and specific crashes in which seat belts were used.

### Phase II: Test Procedure Development

Develop test conditions that best simulate the most injurious school bus crashes identified through Phase I research.

Develop crash pulses by conducting full scale school bus crash testing at various impact angles.

Develop and validate sled test procedures using the derived crash pulses.

Design and if necessary manufacture new occupant protection systems and/or incorporate new components or changes into existing systems. Conduct preliminary tests to verify the systems prior to final sled testing.

Design sled test matrix to evaluate the new or altered occupant protection systems.

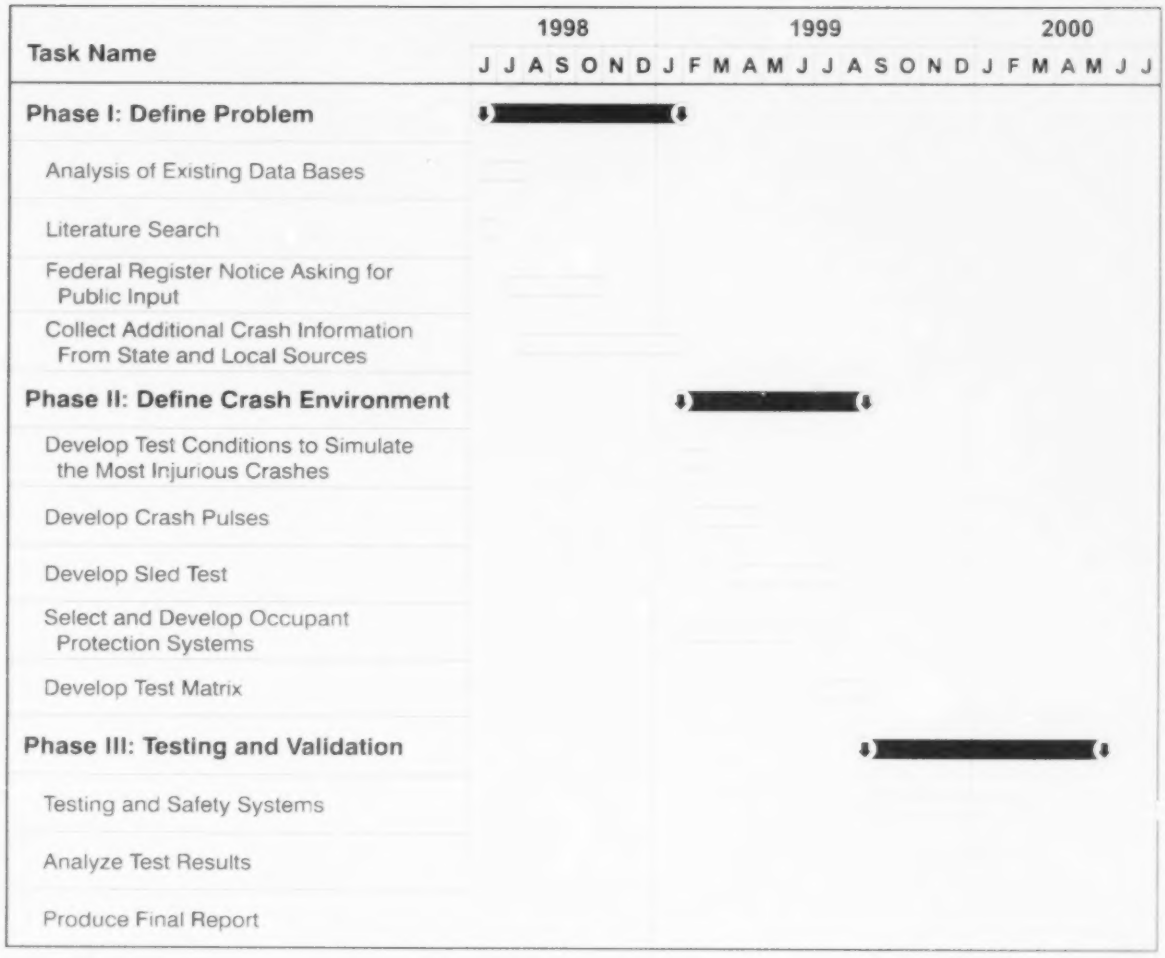
### Phase III: Testing and Validation

Test the various safety systems developed /identified. Conduct both static (i.e., FMVSS 222) and dynamic (new sled test procedure) tests.

Analyze test results.

Produce final report.

# Research Plan


Task Name
1998
1999
2000
J J A S O N D J F M A M J J A S O N D J F M A M J J
Phase I: Define Problem
Analysis of Existing Data Bases
Literature Search
Federal Register Notice Asking for Public Input
Collect Additional Crash Information From State and Local Sources
Phase II: Define Crash Environment
Develop Test Conditions to Simulate the Most Injurious Crashes
Develop Crash Pulses
Develop Sled Test
Select and Develop Occupant Protection Systems
Develop Test Matrix
Phase III: Testing and Validation
Testing and Safety Systems
Analyze Test Results
Produce Final Report

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AUGUST 1998

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**National Highway Traffic Safety Administration**